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(54) Electronic identification system

Elektronisches Identifizierungssystem
Système d'identification électronique

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(73) Proprietor: **INTERNATIONAL COMPUTERS
LIMITED**
Putney, London, SW15 1SW (GB)

(72) Inventor: **Turner, Edwin
Marlow, Bucks SL7 2JR (GB)**

(74) Representative: **Guyatt, Derek Charles et al
Fujitsu Services Limited
Observatory House
Windsor Road
Slough Berkshire SL1 2EY (GB)**

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EP-A- 0 534 559 **WO-A-90/05960**
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DescriptionBackground to the Invention

[0001] This invention relates to an electronic identification system comprising a plurality of transponders, and an interrogator for interrogating the transponders to obtain information stored in the transponders. The invention also relates to a transponder for use in such an identification system. The invention is particularly, although not exclusively, concerned with an electronic identification system using radio frequency (RF) technology for communication between the interrogator and the transponders.

[0002] Such an electronic identification system is described for example in European Patent Applications EP 0494114, EP 0585132 and EP 0598624, and in PCT Patent Application WO 93/17404.

[0003] Such systems have many potential applications, such as tagging goods, mail, vehicles or animals. For example, such a system could be used in a retail store to identify goods presented by a customer at a checkout. The transponders could be incorporated in tags attached to the goods or to their packaging. Another application is in the control of packages through a transit route. In this case the transponders would be attached to the packages and interrogated to obtain routing information.

[0004] In conventional transponders of this kind, the data to be output from the transponder when interrogated is stored in a register. In some applications, the amount of stored data may be quite large: for example, in a package routing system, it may be required to hold routing information for each of a number of points in a chain. However, the more data that is stored, the longer it takes to transmit it all when the transponder is interrogated. Moreover, the interrogator has to be able to select the appropriate information from a long string of data.

[0005] European Patent Application 0161779, against which document the claims are delimited, describes an identification system comprising an interrogator and a plurality of transponders. Each transponder includes a RAM containing several pages of data. A specific instruction received from the interrogator causes a specific transponder to respond by transmitting a data stream comprising as many of the pages as are required. Hence, different interrogators may request different amounts of information: for example, one interrogator may require just the first page (PAGE 0), while another interrogator may additionally require pages 1 to 3. However, this requires the interrogator to poll each individual transponder, to specify which pages it requires from that transponder, which introduces extra complexity.

[0006] One object of the invention is to provide a novel method of operating an electronic identification system, which is capable of overcoming the above mentioned

problems without the necessity for the interrogator to poll individual transponders to specify which pages of information it requires.

5 Summary of the invention

[0007] According to the invention an electronic identification system comprises at least one interrogator and a plurality of transponders, wherein each of said transponders includes a plurality of data registers, selection means for selecting one of said registers, and means for transmitting a response signal containing data from the selected register, in response to an interrogation signal from said interrogator;

10 characterised in that

- 20 (a) the selection means in each transponder is non-volatile, whereby the current selection is preserved even when the transponder is powered down;
- 25 (b) the interrogator includes means for transmitting a switching signal to all the transponders; and
- 30 (c) each transponder includes means, responsive to said switching signal, for switching its selection means to select another one of the registers.

25 Brief Description of the Drawings

[0008]

30 Figure 1 is a schematic diagram showing an electronic identification system in accordance with the invention.

35 Figure 2 is a block diagram of an interrogator.

Figure 3 is a flow chart showing the operation of the interrogator.

40 Figure 4 is a block diagram of a transponder.

Figure 5 is a flow chart showing the operation of the transponder.

Description of an Embodiment of the Invention

45 **[0009]** One embodiment of the invention will now be described by way of example with reference to the accompanying drawings.

[0010] Referring to Figure 1, this shows an electronic identification system comprising an interrogator 10 and a plurality of transponders 11. The interrogator is connected to a host computer 12.

[0011] Referring to Figure 2, this shows the interrogator in more detail. The interrogator comprises an RF antenna 20, a transmitter circuit 21, a receiver circuit 22, and a controlling microprocessor 23. The antenna 20 is connected to both the transmitter and receiver circuits, and serves both for transmission and reception. The

transmitter circuit is controlled by the microprocessor and, when powered up, generates an interrogation signal, comprising a continuous RF carrier signal.

[0012] As will be described, any transponders that detect the interrogation signal return a response signal, comprising an RF carrier signal modulated with coded data. The response signal is received by the antenna 20, and passed to the receiver circuit 22. The receiver circuit demodulates the response signal, by mixing it with an RF reference signal derived from the transmitter circuit, and passes the demodulated signal to the microprocessor 23 for decoding. The decoded data is then passed to the host computer 12. When the host computer detects that all the transponders have responded (e.g. because a time-out period has expired with no further responses) the host computer sends an END signal to the microprocessor.

[0013] Figure 3 shows a flowchart of the operation of the microprocessor 23. Initially, the microprocessor powers up the transmitter (step 30), so as to start transmitting the interrogation signal. The microprocessor then enters a loop in which it checks whether the END signal is present (step 31) and whether a response signal has been received from a transponder (step 32). When a response is received, the microprocessor decodes it, and performs a redundancy check to check whether the response is valid (step 33). If the response is not valid (e.g. because two transponders have returned responses simultaneously, so that their responses interfere with each other), the response is ignored and the microprocessor returns to await another response. When a valid response is detected, the microprocessor outputs the decoded data to the host computer and instructs the transmitter to send an ACK signal (step 34). The ACK signal consists of an interruption to the interrogation signal for one clock period, and serves as an acknowledgement to the transponder that its response has been correctly received. The microprocessor then loops back to step 31 to await the next response.

[0014] The microprocessor repeats this process until an END signal is received from the host computer at step 31, indicating that responses have been received from all the transponders. It then checks whether or not switching is enabled in the interrogator (step 35). If so, a SWITCH signal is sent (step 36). This signal consists of an interruption of the RF carrier for two clock periods, and hence is distinguished from the ACK signal. As will be described, the SWITCH signal steps a counter in each transponder that receives it. If switching is not enabled, no SWITCH signal is sent. Finally, the transmitter is powered down (step 37).

[0015] Referring now to Figure 4, this shows one of the transponders in more detail. The transponder comprises an antenna 40, a power supply 41, a code generator 42, a modulator 43, a variable attenuator 44, gap detection logic 45, a clock circuit 46, a counter 47, a plurality of data registers 48, and a data selector 49.

[0016] The antenna 40 serves for both transmission and reception and may, for example, comprise a printed conductive pattern. The power supply 41 comprises a diode, which rectifies the received RF signal and charges a capacitor. Thus, the transponder derives all its power from the incoming RF signal, and does not require any internal power source. The power supply provides power for the code generator, clock circuit and gap detection logic.

[0017] Each of the data registers 48 holds a data item to be returned to the interrogator when the transponder is interrogated. The data registers 48 are stored in a non-volatile memory, so that their contents are preserved even when the transponder is powered down.

[0018] This non-volatile memory may be of the type which can be re-written, or may be of the type which, once written to, cannot be re-written.

[0019] The data selector circuit 49 selects one of these data registers, according to the value of the counter 47. The output of the selected data register is fed to the code generator 42, which encodes the contents of this data register, e.g. using a Manchester code. The modulator 43 modulates this coded signal on to the carrier wave received from the antenna, and feeds this modulated carrier by way of the attenuator 44 to the antenna 40, for transmission as a response signal.

[0020] One of the bits (e.g. the most significant bit) of the selected data register is used as a control bit for the attenuator 44. When this bit is true, the attenuator reduces the power level of the response signal from its normal level to a lower level. In other words, the transponder has two modes: a normal power mode and a reduced power mode. In the normal power mode, the signal level is such that it can be detected by the interrogator from a range of typically 2 metres. In the reduced power mode, on the other hand, the signal level is such that it can be detected only from a range of 10 centimetres or less.

[0021] The gap detection logic 45 detects both ACK signals and SWITCH signals. The SWITCH signal causes the counter 47 to be incremented, so that it selects the next data register in sequence. The counter 47 is cyclic, so that when it passes its maximum count value, it returns to zero. The counter 47 is stored in a re-writable non-volatile memory, so that its contents are preserved even when the transponder is powered down.

[0022] Figure 5 is a flowchart showing the operation of the transponder. The code generator is powered up whenever an interrogation signal is received from the interrogator (step 50). When powered up, the code generator starts an internal counter, which generates a pre-set delay period (step 51). This delay period is chosen at random for each transponder so that, in general, each transponder has a different delay. The transponder then enters a loop (step 52) in which it waits for this delay period to expire. When the delay period expires, the code generator sends the data from the currently selected data register to the modulator for transmission as a

response to the interrogation signal (step 53).

[0022] The transponder then waits for a predetermined number of clock periods, and then checks whether an ACK has been detected (step 54). If no ACK is detected at the appropriate time, this indicates that the response has not been correctly received by the interrogator, probably because of interference with another transponder. In this case, the transponder returns to step 51, restarting the delay period, and the response is retransmitted after the delay expires. It can be seen that, if the delay periods of the two interfering transponders are different, they will retransmit at different times, and so avoid interference.

[0023] When an ACK is detected, transmission is disabled (step 55), so that no further responses are sent. The transponder then enters a loop (step 56), waiting for a SWITCH signal. When a SWITCH is received, the transponder increments the counter 47 (step 57) and then enters an idle loop (step 58), in which it remains until power is removed. If, however, the transponder is powered down before any SWITCH signal is received, the counter remains in its current state.

[0024] One application of the identification system described above is in a system for automatically routing packages. The transponders may, for example, be incorporated into tags or labels attached to packages to be routed. The registers in each transponder are programmed with the addresses of successive sorting points along the route.

[0025] Each sorting point along the route includes an interrogator which reads the transponders attached to a batch of packages, and passes the information to its local host computer, so that the computer can determine how the packages are to be routed to the next routing point. When all the packages in a batch have been interrogated, the interrogator issues a SWITCH signal, which causes the counters in all the transponders to be incremented, so that the next register is selected.

[0026] An alternative application of the identification system described above is in a retail store. Each item in the store has a label containing a transponder. The first register in each item contains an identity code identifying the item. The control bit of this first register is set to "1" so that when this register is selected, the transponder is put into its high power mode. The second register in each item contains other information, which may be required after purchase of the item. The control bit of this second register is set to "0" so that when this register is selected, the transponder is put into its low power mode. Initially, the counter in each transponder is set to select the first register.

[0027] When a customer wishes to purchase one or more items, the customer passes the items through a checkout station which contains an interrogator as described above. The interrogator interrogates the transponders, so as to obtain their identity codes, and passes these codes to a point-of-sale computer for pricing. After all the transponders have been interrogated the interro-

gator sends a SWITCH signal. This steps the counters in all the transponders so that they now select the second register. This puts all the transponders into the reduced power mode.

- 5 [0028] The store has one or more anti-theft gates, positioned at the store exits. Each of these gates contains an interrogator, which interrogates any transponders that pass it. The anti-theft gate is designed so that it is impossible to bring any transponder closer than about 15 centimetres to the antenna of the interrogator. This means that any transponder in the reduced power mode will not be detected by the anti-theft gate, because its signal power level is insufficient to be detected over a range greater than 10 centimetres. However, any transponder still in the normal power mode will be detected, and this will trigger an audible or visible alarm.
- 10 [0029] In summary, it can be seen that when goods are taken through the checkout, their transponders are modified so as to reduce their signal power levels. This ensures that the goods will not erroneously trigger the anti-theft gate when they are taken out of the store, or if they are subsequently brought back into the store (e.g. as an item of clothing worn by the customer). However, it is still possible to interrogate the transponders if required, using equipment that can accept the reduced signal power level. For example, a customer services desk in the store may contain an interrogator, positioned immediately under the counter so that transponders may be brought very close to the interrogator's antenna.
- 15 [0030] Such an interrogator would therefore be able to read the transponders of articles that had been purchased and returned for exchange or refund.
- 20 [0031] It will be appreciated that many modifications may be made to the system described above without departing from the scope of the invention.
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Claims

- 40 1. An electronic identification system comprising at least one interrogator (10) and a plurality of transponders (11), wherein each of said transponders includes a plurality of data registers (48), selection means (47) for selecting one of said registers, and means (42,43) for transmitting a response signal containing data from the selected register, in response to an interrogation signal from said interrogator;
- 45 **characterised in that**
- 50
 - (a) the selection means (47) in each transponder (11) is non-volatile, whereby the current selection is preserved even when the transponder is powered down;
 - 55 (b) the interrogator (10) includes means (36) for transmitting a switching signal to all the transponders; and
 - (c) each transponder (11) includes means (45),

- responsive to said switching signal, for switching its selection means (47) to select another one of the registers.
2. A system according to Claim 1 wherein the interrogator (10) transmits said switching signal after it has received response signals from all the transponders (11). 5
3. A system according to Claim 1 or 2 wherein said selection means (47) comprises means for selecting said registers in a predetermined sequence. 10
4. A system according to Claim 3 wherein the selection means comprises a counter (47). 15
5. A system according to Claim 4 wherein said counter (47) has a cyclic count sequence. 20
6. A system according to any preceding claim including means (44) for using a predetermined bit of the currently selected one of said registers to switch the transponder between a first mode, in which said response signal has a first predetermined power level, and a second mode in which said response signal has a second, lower predetermined power level. 25
7. A system according to Claim 6 including a plurality of interrogators, wherein at least one of said interrogators is capable of detecting said response signal at said first power level but not at said second power level, and wherein at least one other of said interrogators is capable of detecting said response signal at both said first and second power levels. 30
8. A transponder for an electronic identification system, said transponder including a plurality of data registers (48), selection means (47) for selecting one of said registers, and means (42,43) for transmitting a response signal containing data from the selected register, in response to an interrogation signal from an interrogator;
characterised in that
- (a) the selection means (47) is non-volatile, whereby the current selection is preserved even when the transponder is powered down;
 - (b) the transponder (11) includes means (40) for receiving a switching signal from an interrogator; and
 - (c) the transponder (11) includes means (45), responsive to said switching signal, for switching its selection means (47) to select another one of the registers.
9. A transponder according to Claim 8 wherein said selection means (47) comprises means for selecting said registers in a predetermined sequence. 55
10. A transponder according to Claims 8 or 9 including means (44) for using a predetermined bit of the currently selected one of said registers (48) to switch the transponder between a first mode, in which said response signal has a first predetermined power level, and a second mode in which said response signal has a second, lower predetermined power level. 60

Patentansprüche

1. Elektronisches Identifizierungssystem mit mindestens einer Abfrageeinrichtung (10) und einer Vielzahl von Transpondern (11), wobei jeder Transponder eine Vielzahl von Datenregistern (48), eine Auswählvorrichtung (47) zum Auswählen eines der Register, und eine Vorrichtung (42, 43) zum Übertragen eines Ansprechsignals, das Daten aus dem ausgewählten Register enthält, in Abhängigkeit von einem Abfragesignal aus der Abfrageeinrichtung aufweist, **dadurch gekennzeichnet, dass**
 - a) die Auswählvorrichtung (47) in jedem Transponder (11) nicht flüchtig ist, wobei die jeweilige Auswahl selbst dann erhalten bleibt, wenn der Transponder gegen Ausfall der Versorgungsspannung geschützt ist,
 - b) die Abfrageeinrichtung (10) eine Vorrichtung (36) zum Übertragen eines Schaltsignals an alle Transponder enthält, und
 - c) jeder Transponder (11) eine Vorrichtung (45) besitzt, die auf das Schaltsignal anspricht, um seine Auswählvorrichtung (47) zum Auswählen eines anderen Registers zu schalten.
2. System nach Anspruch 1, bei dem die Abfrageeinrichtung (10) das Schaltsignal überträgt, nachdem es Ansprechsignale aus allen Transpondern (11) empfangen hat. 40
3. System nach Anspruch 1 oder 2, bei dem die Auswählvorrichtung (47) eine Vorrichtung zum Auswählen der Register in einer vorbestimmten Folge aufweist. 45
4. System nach Anspruch 3, bei dem die Auswählvorrichtung einen Zähler (47) besitzt. 50
5. System nach Anspruch 4, bei dem der Zähler (47) eine zyklische Zählfolge hat. 55
6. System nach einem der vorausgehenden Ansprüche, mit einer Vorrichtung (44) zur Verwendung eines vorbestimmten Bits des jeweils ausgewählten Registers, um den Transponder zwischen einer ersten Betriebsart, in der das Ansprechsignal einen ersten vorbestimmten Leistungspegel hat, und ei-

- ner zweiten Betriebsart, in der das Ansprechsignal einen zweiten, niedrigeren vorbestimmten Leistungspegels hat, zu schalten.
7. System nach Anspruch 6, mit einer Vielzahl von Abfrageeinrichtungen, wobei mindestens eine der Abfrageeinrichtungen in der Lage ist, das Ansprechsignal bei dem ersten Leistungspegel, jedoch nicht bei dem zweiten Leistungspegel zu detektieren, und wobei mindestens eine andere der Abfrageeinrichtungen in der Lage ist, das Ansprechsignal sowohl bei dem ersten als auch dem zweiten Leistungspegel zu detektieren. 5
8. Transponder für ein elektronisches Identifizierungssystem, wobei der Transponder eine Vielzahl von Datenregistern (48), eine Auswählvorrichtung (47) zum Auswählen eines der Register, und eine Vorrichtung (42, 43) zum Übertragen eines Ansprechsignals, das Daten aus dem ausgewählten Register enthält, in Abhängigkeit von einem Abfragesignal aus einer Abfrageeinrichtung aufweist,
dadurch gekennzeichnet, dass 15
- a) die Auswählvorrichtung (47) nicht flüchtig ist, wobei die jeweilige Auswahl selbst dann erhalten bleibt, wenn der Transponder gegen Ausfall der Versorgungsspannung geschützt ist,
 - b) der Transponder (11) eine Vorrichtung (40) zum Aufnehmen eines Schaltsignals aus einer Abfrageeinrichtung aufweist, und
 - c) der Transponder (11) eine Vorrichtung (45) besitzt, die auf das Schaltsignal anspricht, um seine Auswählvorrichtung (47) zum Auswählen eines anderen Registers zu schalten.
9. Transponder nach Anspruch 8, bei dem die Auswählvorrichtung (47) eine Vorrichtung zum Auswählen der Register in einer vorbestimmten Folge aufweist. 20
10. Transponder nach Anspruch 8 oder 9, mit einer Vorrichtung (44) zur Verwendung eines vorbestimmten Bits des jeweils ausgewählten Registers (48) aufweist, um den Transponder zwischen einer ersten Betriebsart, in der das Ansprechsignal einen ersten vorbestimmten Leistungspegel hat, und einer zweiten Betriebsart, in der das Ansprechsignal einen zweiten, niedrigeren vorbestimmten Leistungspegel hat, zu schalten. 25
- des moyens de sélection (47) pour sélectionner l'un desdits registres, et des moyens (42,43) pour transmettre un signal de réponse contenant des données provenant du registre sélectionné, en réponse avec un signal d'interrogation provenant dudit interrogateur;
- caractérisé en ce que**
- (a) les moyens de sélection (47) situés dans chaque transpondeur (1) sont non volatils, ce qui a pour effet que la sélection actuelle est sauvegardée même lorsque le transpondeur est débranché;
 - (b) l'interrogateur (10) comprend des moyens (36) pour transmettre un signal de commutation à l'ensemble des transpondeurs, et
 - (c) chaque transpondeur (11) comprend des moyens (45), aptes à répondre au signal de commutation pour commuter ces moyens de sélection (47) pour sélectionner un autre des registres.
2. Système selon la revendication 1, dans lequel l'interrogateur (10) transmet ledit signal de commutation après qu'il a reçu des signaux de réponse de la part de tous les transpondeurs (11). 30
3. Système selon la revendication 1 ou 2, dans lequel lesdits moyens de sélection (47) comprennent des moyens pour sélectionner lesdits registres selon une séquence prédéterminée.
4. Système selon la revendication 3, dans lequel les moyens de sélection comprennent un compteur (47). 35
5. Système selon la revendication 4, dans lequel ledit compteur (47) possède une séquence de comptage cyclique. 40
6. Système selon l'une quelconque des revendications précédentes, comprenant des moyens (44) pour utiliser un bit prédéterminé de l'un actuellement sélectionné desdits registres pour commuter le transpondeur entre un premier mode, dans lequel ledit signal de réponse possède un premier niveau de puissance prédéterminé, et un second mode, dans lequel ledit signal de réponse possède un second niveau de puissance inférieur prédéterminé. 45
7. Système selon la revendication 6, comprenant une pluralité d'interrogateurs, dans lequel au moins l'un desdits interrogateurs peut détecter ledit signal de réponse audit premier niveau de puissance, mais pas audit second niveau de puissance, et dans lequel au moins l'autre desdits interrogateurs est capable de détecter ledit signal de réponse à la fois auxdits premier et second niveaux de puissance. 50

Revendications

1. Système d'identification électronique comprenant au moins un interrogateur (10) et une pluralité de transpondeurs (11), dans lequel chacun desdits transpondeurs inclut une pluralité de registres (48), 55

8. Transpondeur pour un système d'identification électronique, ledit transpondeur comprenant une pluralité de registres de données (48), des moyens de sélection (47) pour détecter l'un desdits registres, et des moyens (42,43) pour transmettre un signal de réponse contenant des données provenant du registre sélectionné, en réponse à un signal d'interrogation provenant d'un interrogateur;

caractérisé en ce que

10

(a) les moyens de sélection (47) sont non volatils, ce qui a pour effet que la sélection actuelle est sauvegardée même lorsque le transpondeur est débranché;

(b) le transpondeur (11) comprend des moyens (40) pour recevoir un signal de commutation de la part d'un interrogateur; et

(c) le transpondeur (11) inclut des moyens (45) aptes à répondre audit signal de commutation, pour commuter ses moyens de sélection (47) afin de sélectionner un autre des registres.

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9. Transpondeur selon la revendication 8, dans lequel lesdits moyens de sélection (47) comprennent des moyens pour sélectionner lesdits registres dans une séquence prédéterminée.

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10. Transpondeur selon la revendication 8 ou 9, comprenant des moyens (44) pour l'utilisation d'un bit prédéterminé de celui actuellement sélectionné desdits registres (48) pour commuter le transpondeur entre un premier mode, dans lequel ledit signal de réponse possède un premier niveau de puissance prédéterminé, et un second mode, dans lequel ledit signal de réponse possède le second niveau de puissance inférieur prédéterminé.

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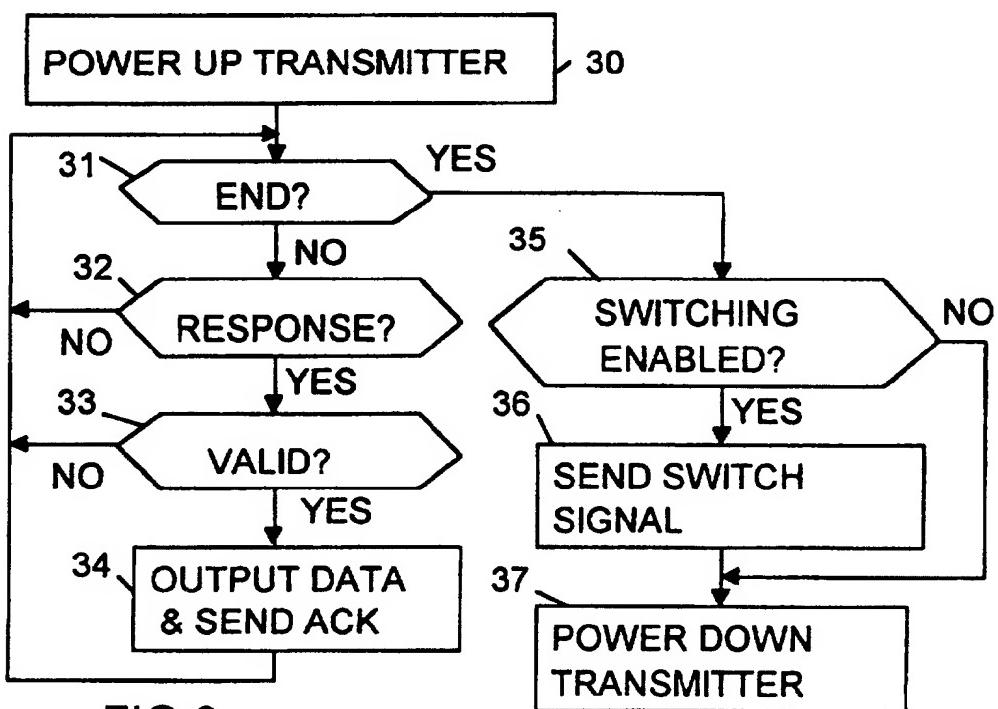
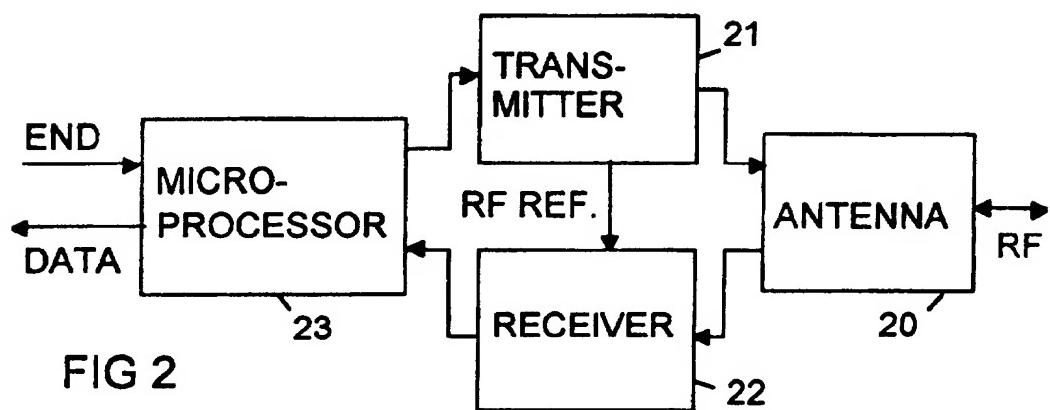
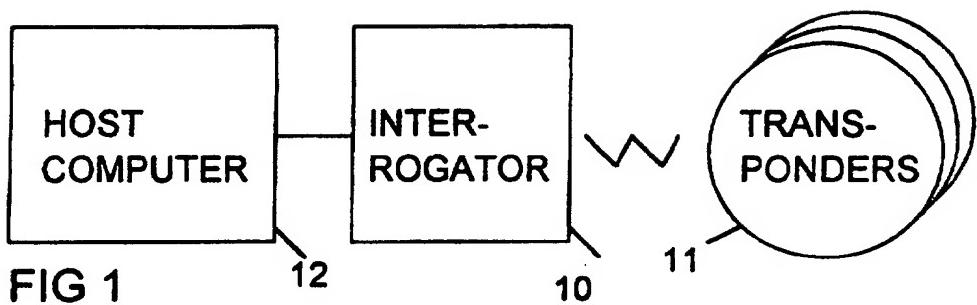
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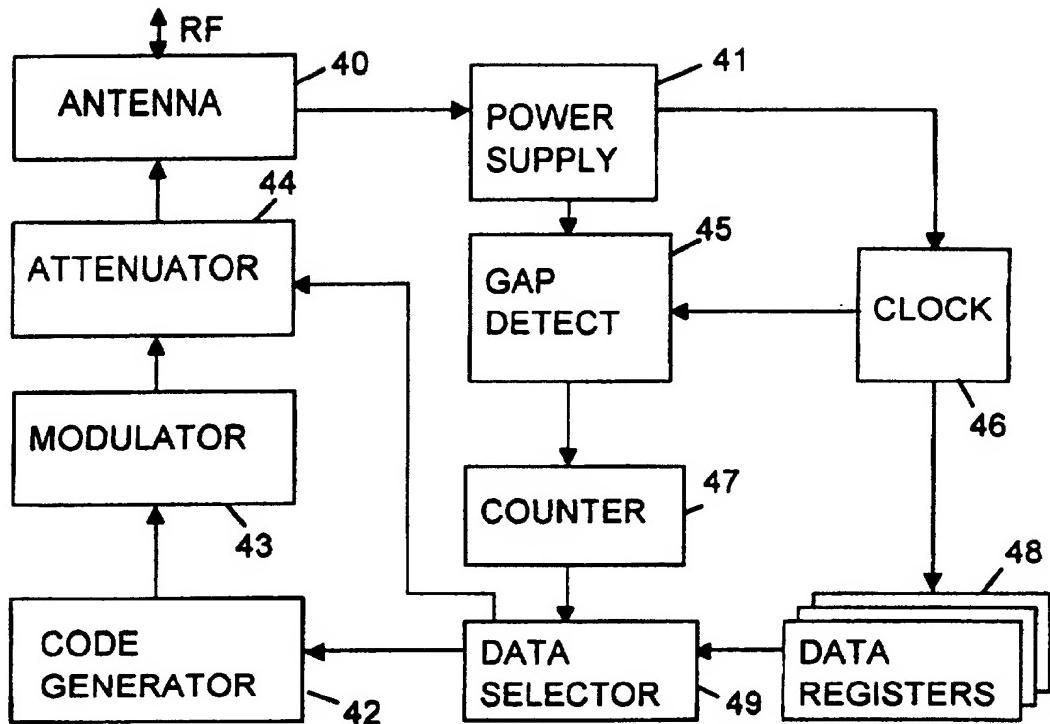


FIG 4

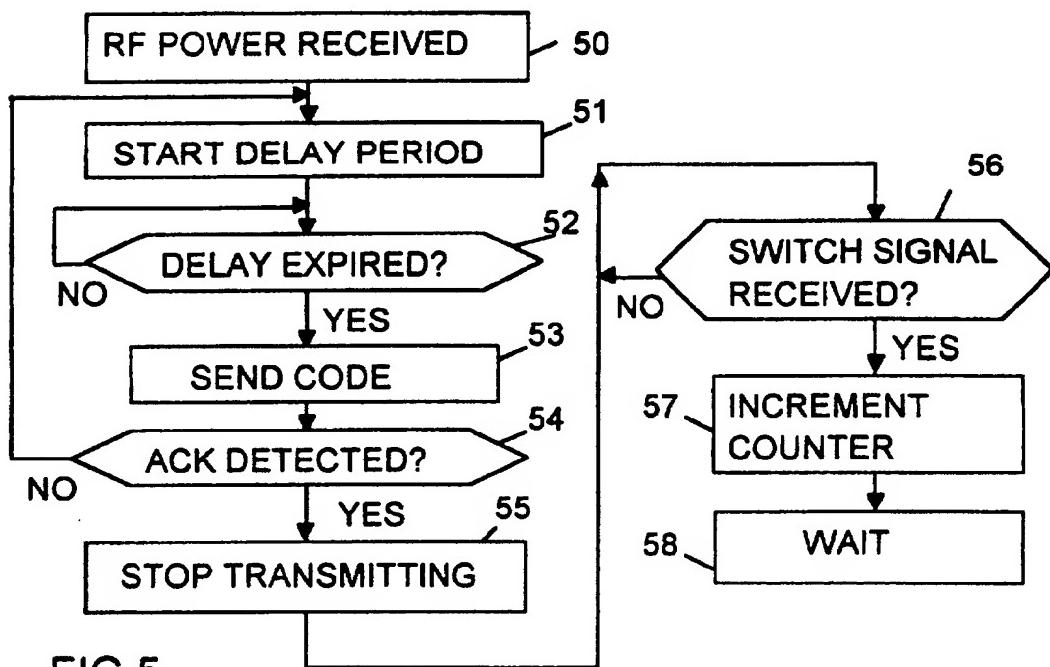


FIG 5